Driven-Dissipative Phase Transition in a Kerr Oscillator

Xin H H Zhang and Harold U Baranger

Duke University, Dept of Physics, Science Dr, Durham 27708-0305, USA

We study open quantum many-body physics using a minimal model, namely a Kerr non-linear oscillator subject to two-photon driving and single-photon dissipation. Using mean-field theory, exact diagonalization, and the Keldysh formalism, we analyze the critical phenomena at the quantum phase transition in this system, showing which aspects can be captured by each approach and how the approaches complement each other [1].

Critical scaling and finite-size scaling are calculated analytically using the quantum Langevin equation. Spectral properties are given analytically using the Keldysh formalism (both the spectral function of the oscillator and the power-spectrum of the emitted photons).

The physics contained in this simple model is surprisingly rich: it includes a continuous phase transition, Z_2 symmetry breaking, PT-symmetry, state squeezing, and critical fluctuations. Due to its simplicity and solvability, this model can serve as a paradigm for exploration of open quantum many-body physics.

[1] X. H. H. Zhang and H. U. Baranger, Phys. Rev. A 103, 033711 (2021).